

## CLAIMS

What is claimed is:

- 1    1.     A method comprising:  
2         producing a medium access control (MAC) packet that includes a source  
3         application-layer timestamp, source data, and a source MAC-layer timestamp,  
4         wherein the source MAC-layer timestamp is based on a substantially synchronized  
5         clock between a source device and a destination device, and the source MAC-layer  
6         timestamp indicates a time when the source data is provided for transmission across  
7         a portion of a system that is subject to variable delays.
- 1    2.     The method of claim 1, further comprising:  
2         receiving an application-layer packet from a source application, wherein the  
3         application-layer packet includes the source application-layer timestamp and the  
4         source data; and  
5         generating the source MAC-layer timestamp in response to receiving the  
6         application-layer packet.
- 1    3.     The method of claim 2, wherein generating the source MAC-layer  
2         timestamp comprises:  
3         generating the source MAC-layer timestamp when the application-layer  
4         packet enters a medium access control layer of the source device.
- 1    4.     The method of claim 1, further comprising:  
2         receiving an application-layer packet from a source application, wherein the  
3         application-layer packet includes the source application-layer timestamp, the source  
4         data, and the source MAC-layer timestamp.

- 1 5. The method of claim 4, further comprising:  
2 providing access to the substantially synchronized clock to the source  
3 application.
- 1 6. The method of claim 1, further comprising:  
2 establishing a fixed transport delay value for the destination device to use to  
3 schedule delivery of the source data to a destination application.
- 1 7. The method of claim 6, wherein determining the delay value comprises:  
2 performing a negotiation process between the source device and the  
3 destination device to determine the fixed transport delay value.
- 1 8. The method of claim 6, wherein determining the delay value comprises:  
2 determining a longest observed delay between the source device and the  
3 destination device to determine the fixed transport delay value.
- 1 9. The method of claim 1, further comprising:  
2 transmitting the MAC packet toward the destination device.
- 1 10. The method of claim 1, wherein the source device is a wireless local area  
2 network communications device, and wherein producing the MAC packet is  
3 performed by a medium access control device of the source device.
- 1 11. A method comprising:  
2 calculating a transport delay experienced by a medium access control  
3 (MAC) packet due to a variable delay between a source device and a destination  
4 device, wherein the MAC packet includes a source MAC-layer timestamp, a source  
5 application-layer timestamp, and source data, and the transport delay is calculated  
6 based on the source MAC-layer timestamp and a destination MAC-layer timestamp  
7 generated based on a substantially synchronized clock between the source device  
8 and the destination device.

1 12. The method of claim 11, further comprising:  
2 a destination application using the transport delay and the source  
3 application-layer timestamp to perform an application clock recovery process.

1 13. The method of claim 11, further comprising:  
2 generating a destination MAC-layer timestamp, which indicates an  
3 approximate time when the source data is ready to be provided to a destination  
4 application, wherein the destination MAC-layer timestamp is based on the  
5 substantially synchronized clock, and the destination MAC-layer timestamp and the  
6 source MAC-layer timestamp are used in calculating the transport delay.

1 14. The method of claim 11, further comprising:  
2 establishing a fixed transport delay value for the destination device to use to  
3 schedule delivery of the source data to a destination application; and  
4 delaying delivery of the MAC packet to the destination application by a  
5 retiming delay, which is approximately equal to the fixed transport delay value  
6 minus the transport delay.

1 15. The method of claim 14, further comprising:  
2 discarding the source data if the transport delay exceeds the fixed transport  
3 delay value.

1 16. The method of claim 14, wherein establishing the fixed transport delay value  
2 comprises:  
3 performing a negotiation process between the source device and the  
4 destination device to determine the fixed transport delay value.

1 17. The method of claim 14, wherein establishing the fixed transport delay value  
2 comprises:  
3 determining a longest observed delay between the source device and the  
4 destination device to determine the fixed transport delay value.

1 18. The method of claim 11, further comprising:  
2 providing access to the substantially synchronized clock to the destination  
3 application, to enable the destination application to calculate the destination  
4 transport delay and to perform a clock recovery process.

1 19. The method of claim 11, wherein the destination device is a wireless local  
2 area network communications device, and wherein calculating the transport delay is  
3 performed by a medium access control element of the destination device.

1 20. A method comprising:  
2 producing, by a source device, a medium access control (MAC) packet that  
3 includes a source application-layer timestamp, source data, and a source MAC-layer  
4 timestamp, wherein the source MAC-layer timestamp is based on a substantially  
5 synchronized clock between the source device and a destination device, and the  
6 source MAC-layer timestamp indicates a time when the source data is provided for  
7 transmission across a portion of a system that is subject to variable delays;  
8 transmitting the MAC packet from the source device to the destination  
9 device; and  
10 calculating, by the destination device, a transport delay applied to the MAC  
11 packet based on the source MAC-layer timestamp and a destination MAC-layer  
12 timestamp generated based on the substantially synchronized clock.

1 21. The method of claim 20, further comprising:  
2 establishing a fixed transport delay value for the destination device to use to  
3 schedule delivery of the source data to a destination application; and  
4 the destination device delaying delivery of the source data to the destination  
5 application by a retiming delay that is approximately equal to the fixed transport  
6 delay value minus the transport delay.

1 22. The method of claim 20, further comprising:  
2 generating a destination MAC-layer timestamp, which indicates an  
3 approximate time when the source data is ready to be provided to a destination  
4 application, wherein the destination MAC-layer timestamp is based on the  
5 substantially synchronized clock, and the destination MAC-layer timestamp and the  
6 source MAC-layer timestamp are used in calculating the transport delay.

1 23. An apparatus comprising:  
2 a medium access control (MAC) packet production element, which produces  
3 a MAC packet that includes a source application-layer timestamp, source data, and a  
4 source MAC-layer timestamp, wherein the source MAC-layer timestamp is based  
5 on a substantially synchronized clock between a source device and a destination  
6 device, and the source MAC-layer timestamp indicates a time when the source data  
7 is provided for transmission across a portion of a system that is subject to variable  
8 delays; and  
9 a clock that is capable of being used as the substantially synchronized clock.

1 24. The apparatus of claim 23, further comprising:  
2 a source application interface, which receives an application-layer packet  
3 from a source application, wherein the application-layer packet includes the source  
4 application-layer timestamp and the source data; and  
5 a timestamp generation element, which generates the source MAC-layer  
6 timestamp in response to receiving the application-layer packet.

1 25. The apparatus of claim 23, further comprising:  
2 a source application interface, which receives an application-layer packet  
3 from a source application, wherein the application-layer packet includes the source  
4 application-layer timestamp, the source data, and the source MAC-layer timestamp.

1 26. The apparatus of claim 23, further comprising:  
2 a clock interface, which enables the substantially synchronized clock to be  
3 provided to a source application.

1 27. The apparatus of claim 23, wherein the apparatus forms a portion of a  
2 wireless local area network device, and the apparatus further comprises:  
3 an antenna for transmitting the MAC packet over a device-to-device  
4 communication link.

1 28. An apparatus comprising:  
2 a transport delay calculation element, which calculates a transport delay  
3 applied to a medium access control (MAC) packet, wherein the MAC packet  
4 includes a source MAC-layer timestamp, a source application-layer timestamp, and  
5 source data, and the transport delay is calculated based on the source MAC-layer  
6 timestamp and a substantially synchronized clock between the source device and the  
7 destination device; and  
8 a clock that is capable of being used as the substantially synchronized clock.

1 29. The apparatus of claim 28, further comprising:  
2 a destination MAC-layer timestamp generation element, which generates a  
3 destination MAC-layer timestamp that indicates an approximate time when the  
4 source data will be provided to a destination application, wherein the destination  
5 MAC-layer timestamp is based on the substantially synchronized clock, and the  
6 destination MAC-layer timestamp and the MAC-layer timestamp are used in  
7 calculating the transport delay.

1 30. The apparatus of claim 28, further comprising:  
2 a fixed transport delay element, which delays delivery of the source data to a  
3 destination application by a retiming delay that is approximately equal to a fixed  
4 transport delay value minus the transport delay.

1 31. The apparatus of claim 28, further comprising:  
2 a clock interface, which enables the substantially synchronized clock to be  
3 provided to a destination application.

1 32. The apparatus of claim 28, wherein the apparatus forms a portion of a  
2 wireless local area network device, and the apparatus further comprises:  
3 an antenna for receiving the MAC packet over an air interface.

1 33. A computer-readable medium having program instructions stored thereon to  
2 perform a method, which when executed within an electronic device, result in:  
3 producing a medium access control (MAC) packet that includes a source  
4 application-layer timestamp, source data, and a source MAC-layer timestamp,  
5 wherein the source MAC-layer timestamp is based on a substantially synchronized  
6 clock between a source device and a destination device, and the source MAC-layer  
7 timestamp indicates a time when the source data is provided for transmission across  
8 a portion of a system that is subject to variable delays.

1 34. The computer-readable medium of claim 33 wherein execution of the  
2 method further results in:  
3 receiving an application-layer packet from a source application, wherein the  
4 application-layer packet includes the source application-layer timestamp and the  
5 source data; and  
6 generating the source MAC-layer timestamp in response to receiving the  
7 application-layer packet.

1 35. The computer-readable medium of claim 33, wherein execution of the  
2 method further results in:  
3 receiving an application-layer packet from a source application, wherein the  
4 application-layer packet includes the source application-layer timestamp, the source  
5 data, and the source MAC-layer timestamp.

1 36. The computer-readable medium of claim 33, wherein execution of the  
2 method further results in:  
3 providing access to the substantially synchronized clock to the source  
4 application.

1 37. A computer-readable medium having program instructions stored thereon to  
2 perform a method, which when executed within an electronic device, result in:  
3 calculating a transport delay experienced by a medium access control  
4 (MAC) packet due to a variable delay between a source device and a destination  
5 device, wherein the MAC packet includes a source MAC-layer timestamp, a source  
6 application-layer timestamp, and source data, and the transport delay is calculated  
7 based on the source MAC-layer timestamp and a destination MAC-layer timestamp  
8 generated based on a substantially synchronized clock between the source device  
9 and the destination device.

1 38. The computer-readable medium of claim 37, wherein execution of the  
2 method further results in:  
3 generating a destination MAC-layer timestamp, which indicates an  
4 approximate time when the source data is ready to be provided to a destination  
5 application, wherein the destination MAC-layer timestamp is based on the  
6 substantially synchronized clock, and the destination MAC-layer timestamp and the  
7 source MAC-layer timestamp are used in calculating the transport delay.

1 39. The computer-readable medium of claim 37, wherein execution of the  
2 method further results in:  
3 establishing a fixed transport delay value for the destination device to use to  
4 schedule delivery of the source data to a destination application; and  
5 delaying delivery of the MAC packet to the destination application by a  
6 retiming delay, which is approximately equal to the fixed transport delay value  
7 minus the transport delay.



1    40.    The computer-readable medium of claim 37, wherein execution of the  
2    method further results in:  
3            providing access to the substantially synchronized clock to the destination  
4    application, to enable the destination application to calculate the transport delay and  
5    to perform a clock recovery process.